Claims

1. A method for electrolytic production of aluminium metal from an electrolyte (3) comprising aluminium oxide, by performing electrolysis comprising at least one inert anode (1) and at least one cathode (2) thus forming part of an electrowinning cell, where the anode evolves oxygen gas and the cathode has aluminium discharged onto it in the electrolysis process, where the said oxygen gas enforces an electrolyte flow pattern,
characterised in that
the oxygen gas is directed to flow into anode grooves and drained away from the interpolar room, and thereby establishing an electrolyte flow pattern between the electrodes (1) and (2) and between and over the anodes (1).

2. An anode assembly for use in accordance with the method defined in claim 1,
characterised in that
the said anodes are shaped to form "teeth" separated by 1-3 cm deep and 1-3 cm wide grooves.

3. An anode assembly in accordance with claim 2,
characterised in that
the bottom of the said anode teeth is V-shaped and sloped 1-5 ° from the centre line towards the groove (4) to efficiently drain the produced gas into the groove.

4. An anode assembly in accordance with claim 2,
characterised in that
the surface of the said anode teeth should be horizontally oriented or angled 1-2 ° , while the bottom of the grooves in the said anode should be sloped 1-5 ° and oriented parallel to the desired bath circulation pattern to obtain efficient drainage of produced gas collected in the grooves (4) and to set up a desired flow pattern in the electrolyte (3).

5. An an[illegible]ssembly in accordance with claim 2 and [illegible]
c h a r a c t e r i s e d i n that
the said anode "teeth" should be 10-20 cm wide to obtain a uniform current density and a low bubble layer resistance, where the length of the teeth are not limited, and can be more than 100 cm.

6. An anode assembly in accordance with claim 2, 4 and 5,
c h a r a c t e r i s e d i n that
the corners and edges on the said anode and grooves are smoothened/rounded to give a uniform flow characteristic and current density.

7. An anode assembly in accordance with claim 2 and 4-6,
c h a r a c t e r i s e d i n that
the top surface of the said anode (13) should be shaped to set up a circulation pattern that distributes fresh electrolyte to all parts of the cell.

8. An anode assembly in accordance with claim 2,
c h a r a c t e r i s e d i n that
the top of the said anode should be insulated (9) above the bath level around the stubs as well as the cathode bottom (7) to make it possible to run the cell thermally in balance with reduced inter polar distance compared to traditional Hall-Heroult cells.

9. An anode assembly in accordance with claim 2,
c h a r a c t e r i s e d i n that
the anode (1) preferentially should be totally immersed in the electrolyte (3) to achieve sufficient electrolyte flow and thermal balance in the cell.

10. An anode assembly in accordance with claim 2,
c h a r a c t e r i s e d i n that
two or more anodes form an anode "cluster" which are connected to anode raisers (6) and via the anode beam to the busbar system in a similar way as prebake carbon anodes do in Hall-Heroult cells of today.

11. An a[illegible]assembly in accordance with claim 2 an[illegible],
c h a r a c t e r i s e d i n that
the said anode clusters are placed with orientation of the grooves in such a way that the produced oxygen in the grooves sets up an electrolytic flow pattern that facilitates sufficient electrolytic flow velocity to obtain uniform distribution of alumina in the cell without sludge formation.

12. An anode assembly in accordance with claim 1,
c h a r a c t e r i s e d i n that
the bottom of the anode facing the cathode can be shaped like a cone or a roof with 3 or more planes with angled or straight surfaces towards a hole (16) in the top where produced anode gas can escape.

13. An anode assembly in accordance with claim 1,
c h a r a c t e r i s e d i n that
the said anodes are manufactured from dimensionally stable materials, preferably oxide based cermets, metals, metal alloys, oxide ceramics, and combinations or composites thereof.

14 . An anode assembly in accordance with claim 1,
c h a r a c t e r i s e d i n that
the said anode can be made of a ceramic outer surface with a good electrical conducting material made of a cermet or a metal or a combination thereof in the centre.

15. An electrowinning cell in accordance with claim 1, 2 and 10,
c h a r a c t e r i s e d i n that
using the said anodes consisting of a plurality of smaller units integrated in one larger unit.

16. An electrowinning cell in accordance with claim 1,

characterised in that

the electrolyte comprises a mixture of sodium fluoride and aluminium fluoride, with possible additional metal fluorides of the group 1 and 2 elements in the periodic table according to the IUPAC system, and the possible components based on alkali or alkaline earth halides up to a fluoride/halide molar ratio of 2.5, and where the NaF/AlF_3 molar ratio is in the range 1 to 3, preferably in the range 1.2 - 2.8.

17. An electrowinning cell in accordance with claim 1,

characterised in that

the said cell using an electrolyte with a temperature in the range 880 - 970°C .

18. An electrowinning cell in accordance with claim 1,

characterised in that

the said cell is connected to at least one gas exhaust system for extracting and collecting gases from the electrolysis chamber.

19. An electrowinning cell in accordance with claim 1,

characterised in that

it comprises the exhaust system which is connected to the alumina feeding system (11) in which the hot off-gases are used for heating the alumina feed stock and/or used for scrubbing cleaning of the off-gasses from the cell to remove fluoride vapours, fluoride particulates and/or dust before entering the gas collection system.

20. An electrowinning cell in accordance with claim 1,

characterised in that

the cathodes are manufactured from carbon blocks or carbon covered or mixed with an electrically conductive refractory hard materials (RHM) based on borides, carbides, nitrides, silicides or mixtures thereof.

21. An electrowinning cell in accordance with claim 1 and 20,
characterised in that
the cathode is either oriented horizontally or slightly sloped to drain produced alminium to a metal collector chamber (or ditch).

22. An electrowinning cell in accordance with claim 1,
characterised in that
the aluminium pool acting as a cathode should be stabilised by optimising the busbar system magnetic field.

23. An electrowinning cell in accordance with claim 1,
characterised in that
the cell has a sidewall lining that preferably consists of an electrically non-conductive material.

24. An electrowinning cell in accordance with claim 1,
characterised in that
the material of the cell sidewall lining is selected from aluminium oxide, aluminium nitride, silicon carbide, silicon nitride, and combinations thereof or composites thereof.

25. An electrowinning cell in accordance with claim 1,
characterised in that
the anodes and/or cathodes are connected to a periphery busbar system for electrical supply of cells arranged "end-to-end" or "side-by-side".

26. An electrowinning cell in accordance with claim 1,
characterised in that
the anodes and/or the anode connections can be cooled to provide heat exchange and/or heat recovery from said anode/cathode, and/or temperature control.

27. An electrowinning cell in accordance with claim 1 and 26,

characterised in that

the said anodes and/or the anode connections can be cooled by means of water cooling or other liquid coolants, by gas cooling or by the use of heat pipes.

28. An electrowinning cell in accordance with claim 1 and 2,

characterised in that

it comprises at least one feeding point (11) for alumina which is located at a position being close to high-turbulence areas in the electrolyte, and in the area between two or more of the said anodes.

29. An electrowinning cell in accordance with claim 1 and 28,

characterised in that

the feeding preferentially is continuos or in very small batches (semi-continuos) and the alumina fed to the cell should contain fine particulates, which are easy to dissolve.

30. An electrowinning cell in accordance with claim 1, 2 and 10,

characterised in that

the said anode clusters' position is optimised with respect to groove orientation and side and centre channels to give the necessary alumina mixing and distribution.